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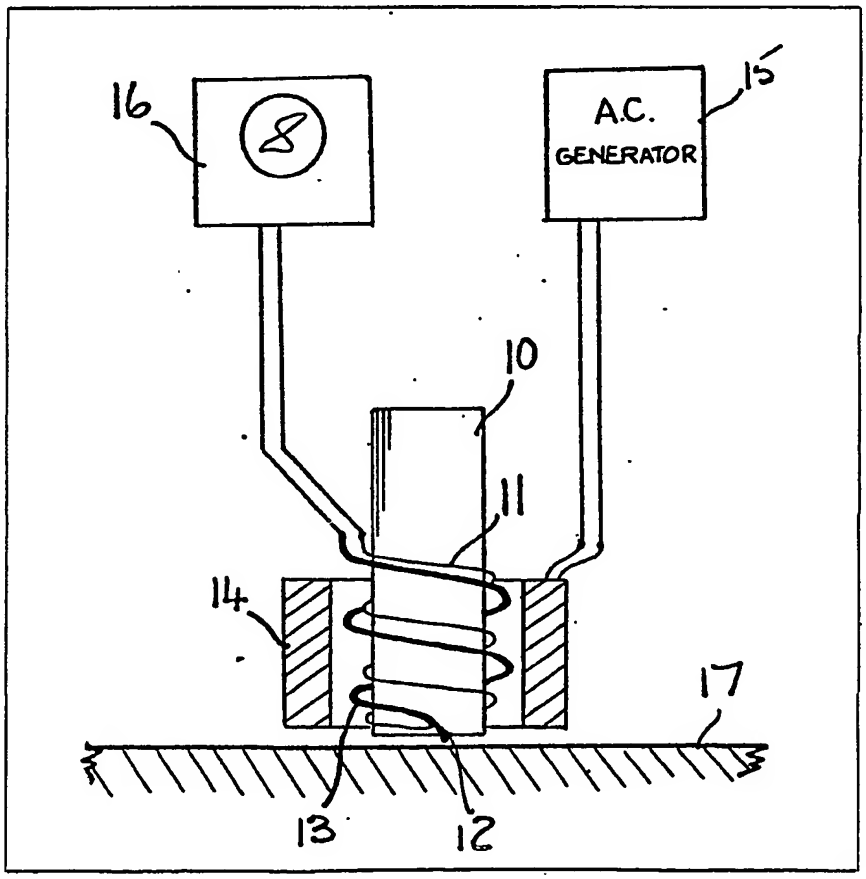
(54) Eddy current test probe

(57) The test probe has two mutually concentric sensing coils, 11, 13 connected in series and wound in opposite directions, the inner coil on a ferrite core 10 and the outer coil on the inner. The sensing coils each have nominally the same number of turns, but are 'balanced' in a calibrating magnetic field to constitute a differential configuration by the addition to or substraction from one coil of a turn or part of a turn. A field coil 14 is wound on the outer sensing coil. The probe has the advantage of being omnidirectional in effective operation in fault location using eddy current techniques.



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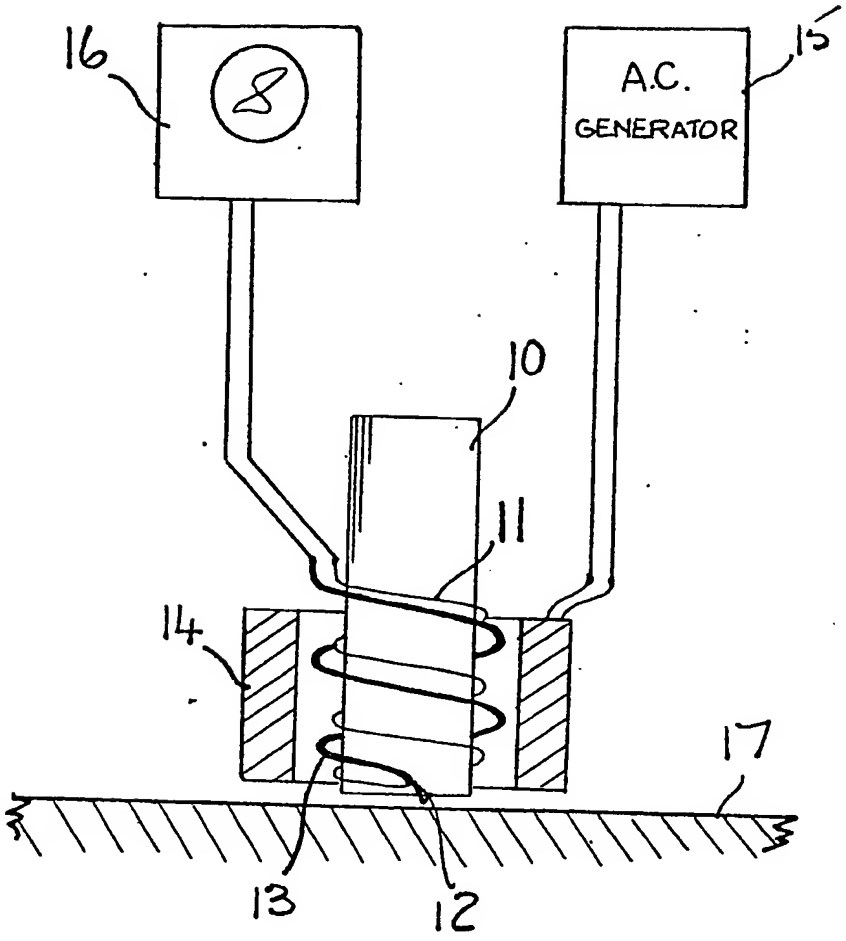
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SPECIFICATION

Eddy current test tube

This invention relates to apparatus for use in locating faults in electrically conductive bodies.

The invention is concerned particularly with such apparatus comprising means for producing a primary magnetic field or excitation field for probing the conductive body to induce eddy currents therein, and means for examining the resultant magnetic field.

In one previous proposal, such apparatus comprises a coil across which an alternating voltage is applied to produce the excitation field, and the same coil serves for examining the resultant field the examination being effected by interpreting changes in phase angles and amplitudes of voltages induced in the coil in relation to the applied voltage. This arrangement, called an 'absolute' configuration, has the disadvantage that there is always a high residual voltage present the removal of which tends to mask small amplitude and phase variations.

In another previous proposal, such apparatus comprises a separate field or excitation coil surrounding a side-by-side pair of sensing coils which are made mutually identical except for one being wound oppositely from the other. The sensing coils are connected in series so that they constitute a 'differential' configuration. In this case, examination of the resultant magnetic field is effected by interpreting the output voltages from the sensing coils in relation to zero volts or null reading. However, this differential configuration has the disadvantage of possessing a directional characteristic which in certain modes of use prevents satisfactory location of some orientations of faults.

An object of the present invention is to provide apparatus for use in locating faults in conductive bodies, in which the above mentioned disadvantages are obviated or mitigated.

According to the present invention, there is provided apparatus for use in locating faults in conductive bodies comprising excitation means for producing an excitation magnetic field, and means for examining a resultant magnetic field produced when, in use, the excitation means is associated with a conductive body to be tested, said examining means comprising two mutually concentric sensing coils connected in series and wound one on the other in mutually opposed directions to constitute a differential configuration.

Preferably, the inner of the said two sensing coils is wound on a core of magnetic material.

Preferably, the magnetic material is ferrite.

Preferably, the excitation means comprises an excitation or field coil.

Preferably, the field coil is arranged concentric with the sensing coils.

Preferably, the field coil is wound on the outer sensing coil.

The excitation means and the means for examining a resultant magnetic field preferably comprise, respectively, an alternating voltage source connected to the field coil, and measuring means connected to the sensing coils and responsive to electrical voltage induced in the sensing coils.

The said measuring means may conveniently include an oscilloscope, and the visual interpretation of the trace based on experimental practice. Alternatively or additionally, the measuring means may include recording means, which may be analogue or digital, and the interpretation of the recorded data may be assisted by means of a programmed data processor.

The field coil and the sensing coils together constitute an assembly known as a probe.

Further, according to the present invention, there is provided for use in the apparatus aforesaid, a probe comprising two mutually concentric sensing coils connected in series and wound one on the other in mutually opposed directions to constitute a differential configuration, and a field coil arranged concentric with the sensing coils.

Preferably, the probe includes a core of magnetic material, preferably ferrite.

In order to constitute a differential configuration, the voltages induced in the sensing coils by a 'calibrating' alternating magnetic field must respectively be mutually equal and of opposite polarity to produce a null reading. In the previously proposed differential configuration, this is achieved, to an accuracy within acceptable tolerances, simply by winding the two sensing coils on similar cores and with the same number of turns. However, the sensing coils in accordance with the present invention, being wound one on or the other are of different diameter. Moreover, the mutually concentric sensing coils are much more closely coupled and therefore more mutually interactive than the coils of the prior arrangement. Accordingly, the mutually concentric sensing coils are 'balanced' by the addition or subtraction to or from one coil of a turn or part of a turn so that a null reading is obtained across both coils while they are in the calibrating field.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawing which is a diagrammatic representation partly in sectional elevation of apparatus in accordance with the present invention.

In the drawing, a cylindrical ferrite core 10 has a single-layer first sensing coil 11 wound directly on to a lower portion of the core. At the lower termination of the first sensing coil 11, the electrical conductor, which is of enamelled copper wire, is folded as at 12 and

a second single-layer sensing coil 13 is wound on the first sensing coil concentric therewith. In the drawing, the sensing coils 11 and 13 are shown diagrammatically with the sensing coil 13 being represented by a heavier line for clarity. It will be understood however that both sensing coils are close-coiled and are of the same conductor material in respect of composition and wire gauge.

A field coil 14, shown diagrammatically in cross section, is arranged concentrically with the sensing coils. In practice, the field coil may be wound on the outer sensing coil.

The three coils and the ferrite core described above constitute a probe assembly and are, in practice, housed or encapsulated for example in a block of plastics material (not shown) with provision made for electrical leads and connections.

The apparatus includes an alternating voltage source 15 which is connected to the field coil 14, and also measuring means in the form of an oscilloscope 16 which is connected to the sensing coils.

The basic principles of eddy current testing are known and it will therfore be appreciated that the various electrical parameters and physical dimensions will be determined having regard to the nature of the material being tested and the depths in such material at which faults are to be located.

Typical physical dimensions for a probe to be used in examining for defects around fasteners in aircraft wing skins would be as follows. The ferrite core 10, 40mm in length and 12mm diameter; the sensing coils 11 and 13 each 80 turns (prior to balancing adjustment) of 43 gauge wire; and the field coil 14 having 600 turns of 36 gauge wire.

A probe thus dimensioned is useful in examining to a depth of the order of 10mm; or at operating frequencies down to 200 hertz.

In use, an altenating voltage applied to the field coil 14 produces an excitation field for probing an article to be tested as shown diagrammatically by reference numeral 17 in the drawing. The presence of the material of the article 17 alters the total impedance of the probe, and the degree of alteration of such impedance is affected by the presence of a fault in the material. Accordingly, the fault may be located by appropriate interpretation of the oscillscope trace.

Since the sensing coils 11 and 13 are mutually concentric, they are omni-directional in effective operation in fault location. The relatively high sensitivity of this probe permits test procedures including rapid linear scans in which serious faults are not missed as could be the case in using a probe having directional characteristics.

In the manufacture or construction of the probe, as has been explained hereinbefore, the sensing coils 11 and 13 are balanced by the addition or subtraction of a turn (or turns) or part of a turn to or from the upper end of one or the other coil while the prolbe is disposed in a calibrating field. The frequency of the calibrating field is chosen with reference to the designed operating frequencies for the tests for which the probe is intended.

CLAIMS

1. Apparatus for use in locating faults in conductive bodies comprising excitation means for producing an excitation magnetic field, and means for examining a resultant magnetic field produced when, in use, the excitation means is associated with a conductive body to be tested, said examining means comprising two mutually concentric sensing coils connected in series and wound one on the other in mutually opposed directions to constitute a differential configuration.

2. Apparatus according to claim 1, wherein the inner of the said two sensing coils is wound on a core of magnetic material.

3. Apparatus according to claim 2, wherein the magnetic material is ferrite.

4. Apparatus according to any one of the preceding claims, wherein the excitation means comprises an excitation or field coil.

5. Apparatus according to claim 4, wherein the field coil is arranged concentric with the sensing coils.

6. Apparatus according to claim 5, wherein the field coil is wound on the outer sensing coil.

7. A probe comprising two mutually concentric sensing coils connected in series and wound one on the other in mutually opposed directions to constitute a differential configuration, and a field coil arranged concentric with the sensing coils.

8. A probe according to claim 7, including a core of magnetic material.

9. A probe according to claim 8, wherein the magnetic material is ferrite.

10. Apparatus for use in locating faults in conductive bodies, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

11. A probe substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

12. Any feature or combination of features herein disclosed.

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